

Three new species of *Simulium* (*Wallacellum*) from Luzon Island, Philippines (Diptera: Simuliidae)

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Abstract: Three new black-fly species, *Simulium* (*Wallacellum*) *suyoense* sp. nov., *S. (W.) claveriaense* sp. nov. and *S. (W.) molawinense* sp. nov., are described based on the females, males, pupae and/or mature larvae collected from Luzon Island, the Philippines. *Simulium* (*W.*) *suyoense* sp. nov. is characterized by the pupal gill with four slender filaments arranged in (2+1)+1 filaments arising from a swollen base and the male style with two apical spines, while *S. (W.) claveriaense* sp. nov. and *S. (W.) molawinense* sp. nov. are characterized by the wall-pocket-shaped cocoon with an eaves-like anterodorsal projection and the shoe-shaped cocoon, respectively. The probable relationships of these new species with certain known species among the subgenus *Simulium* (*Wallacellum*) are discussed.

Key words: black fly, *Simulium*, *Wallacellum*, Philippines, new species

Wallacellum is one of the small homogeneous subgenera in the genus *Simulium* Latreille s. l. and is known to have an insular distribution (Takaoka, 1983, 2003). It consists of eight species recorded from the Philippines (Takaoka, 1983) and one species from both Yonakuni Island, the Ryukyu Islands, Japan (Takaoka, 1972) and Lanyu Island, Taiwan (Chung, 1986), and two species from Indonesia (Takaoka, 2003). According to Takaoka (1983), this subgenus is characterized in the adults by the enlarged calcipala and the hind tibia with a narrowly-constricted low process on the anteromedial surface along its basal 1/3 to 1/2, as well as the haired pleural membrane and katepisternum, in the pupa by the abdominal segments 6–9 devoid of dorsal spine-combs, and abdominal segments 6 and 7 each having an inner hook and lacking an outer hook ventrally on each side, and in the larva by the hanging-bell-shaped postgenal cleft.

In this paper, three new species belonging to the subgenus *Wallacellum* are

described based on the reared adult, pupal and larval specimens collected from Luzon Island, the Philippines.

The terms for morphological features used here follow those of Takaoka (2003). Holotype and paratype specimens of the new species are deposited at the Department of Infectious Disease Control, Faculty of Medicine, Oita University, Oita, Japan.

Simulium (*Wallacellum*) *suyoense* sp. nov.

DESCRIPTION. Female. Body length 2.1–2.4 mm. **Head.** Width as wide as thorax. Frons dark brown, not shiny, densely covered with white scale-like recumbent hairs interspersed with several dark simple longer hairs on each side; frontal ratio 1.41 : 1.00 : 1.38; frons-head ratio 1.00 : 3.45. Fronto-ocular area (Fig. 1A) moderately developed, directed laterally and somewhat upward. Clypeus dark brown, not shiny, densely covered with white scale-like recumbent hairs (except narrow portions along upper and lower margins bare) interspersed

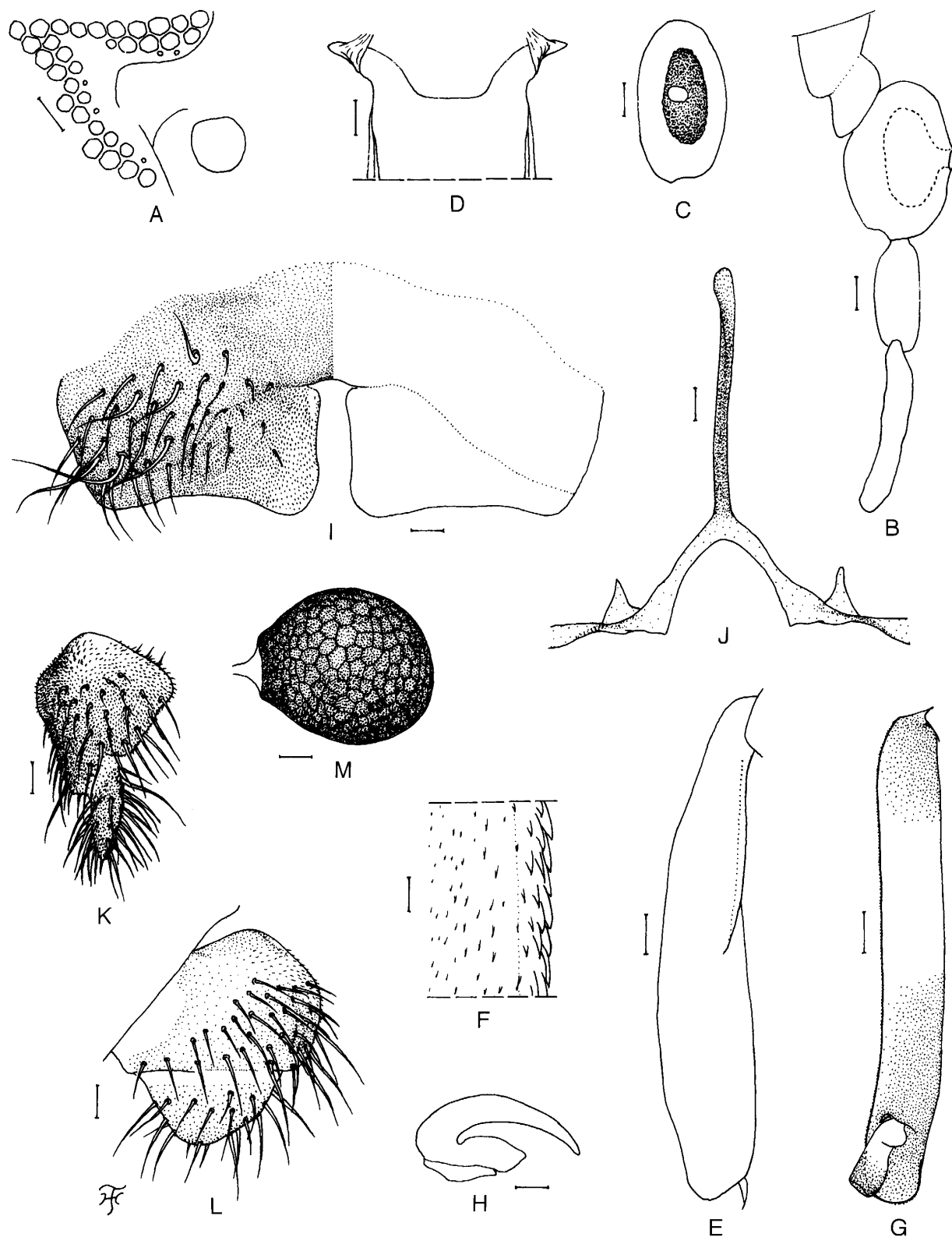


Fig. 1. Female of *Simulium* (*Wallacellum*) *suyoense* sp. nov. A, fronto-ocular area (right side); B, maxillary palp (right side; lateral view); C, 3rd segment of maxillary palp with sensory vesicle (right side; front view); D, cibarium; E, tibia showing a narrowly-constricted low process on its anteromedial surface (left side; inner view); F, part of a narrowly-constricted low process covered with spinous scales; G, basitarsus and 2nd tarsal segment of hind leg showing calcipala and pedisulcus (left side; outer view); H, tarsal claw; I, 8th sternite and ovipositor valves *in situ* (ventral view); J, genital fork (ventral view); K and L, paraprocts and cerci (right side; K, ventral view; L, lateral view); M, spermatheca. Scale bars. 0.05 mm for E and G; 0.03 mm for A-C; 0.02 mm for D and I-M; 0.01 mm for F and H.

with several dark longer usual simple hairs along lateral margins and near lower margin. Labrum 0.94 times as long as clypeus. Antenna composed of 2+9 segments, yellow except apical 4 or 5 flagellar segments grayish, and 1st flagellar segment with dark spot on frontal surface. Maxillary palp (Fig. 1B) composed of 5 segments, medium brown to brownish-black, proportional lengths of 3rd, 4th, and 5th segments 1.00:0.72:1.10; 3rd segment (Fig. 1C) greatly enlarged; sensory vesicle elongated, 0.62 times as long as 3rd segment, with medium-sized opening medially. Lacinia with 9 or 10 inner and 12 outer teeth. Mandible with 18 teeth on inner margin and smooth on outer margin. Cibarium (Fig. 1D) simple, without any tubercle. **Thorax.** Scutum light to medium brown, with 3 medium to dark brown longitudinal vittae (1 medial, 2 submedial), all connected to dark brown prescutellar area, slightly shiny at certain angle of light, moderately or densely covered with yellowish-white scale-like recumbent short hairs interspersed with dark brown upright simple hairs on prescutellar area. Scutellum light to medium brown, with dark upright usual simple hairs as well as yellowish-white scale-like short hairs. Postnotum light to medium brown, not shiny and bare. Pleural membrane densely covered with yellowish-white fine hairs interspersed with a few dark brown hairs. Katepisternum longer than deep, densely covered with dark short hairs. **Legs.** Foreleg: coxa, trochanter and femur medium brown with apical cap of femur dark brown; tibia dark brown with base very narrowly pale, and median large area of outer surface medium brown; tarsus dark brown, with dorsal crest of short hairs moderately developed on segments 1-3; basitarsus slightly dilated, 8.2 times as long as its greatest width. Midleg: coxa medium brown; trochanter light to medium brown; femur ochreous with apical cap dark brown and with light to medium brown broad band medially; tibia dark brown except base narrowly ochreous, and with ochreous narrow band submedially (usually only on outer surface); tarsus entirely dark brown. Hind leg: coxa medium brown; trochanter and femur ochreous to light brown except apical cap of femur dark brown (though widely pale on inner surface of femur); tibia dark brown except base narrowly whitish-yellow to ochreous, and with ochreous band submedially (usually only on outer surface);

tibia (Fig. 1E) with narrowly-constricted low process along shaft extending from base to midpoint on anteromedial surface; this process covered with numerous small spear-shaped spinous scales (Fig. 1F), elaborately arranged on its surface; tarsus dark brown except submedial wide area of basitarsus and basal 1/2 of 2nd segment yellowish-white; basitarsus (Fig. 1G) slender, parallel-sided, 6.21 times as long as wide, 0.72 and 0.54 times as wide as greatest widths of tibia and femur, respectively; saw-like anterior margin of basitarsus curved inward before reaching basal apex; basitarsus furnished with numerous slender hairs all over but without any spine on outer surface (though numerous spines present near base on inner surface); calcipala (Fig. 1G) greatly enlarged, extending to apical end of 2nd tarsal segment, and nearly as wide as apical portion of basitarsus; pedisulcus (Fig. 1G) well developed at basal 1/3 of 2nd tarsal segment. All femora, tibiae and parts of tarsus covered with scale-like hairs as well as usual simple hairs on outer surface. All claws (Fig. 1H) with large basal tooth 0.58 times as long as claw. **Wing.** Length 2.0-2.3 mm. Costa with dark spinules as well as short hairs, with basal hair tuft medium brown; subcosta with hairs on ventral surface; basal portion of radial vein covered with hairs on dorsal surface, rest of radial vein with hairs and dark spinules on dorsal surface; hair tuft at base of radial vein medium brown; basal cell absent; humeral and r-m cross veins dark-spotted. **Abdomen.** Basal scale medium to dark brown, with fringe of white hairs; dorsal surface of abdominal segments dark brown, not shiny, and densely covered with yellowish-white and dark brown scale-like recumbent hairs interspersed with dark usual simple hairs on posterior segments; tergites 2, 7, 8 and 9 much wider than long, extending laterally, and tergites 3-6 narrow, occupying only 1/5-1/4 of dorsal surface of respective segment; ventral surface of abdomen ochreous to light brown, densely covered with yellowish-white and dark scale-like hairs on each side, and moderately covered with dark short hairs medially; sternal plate on segment 7 well developed medially, large, roughly triangular. **Genitalia.** Sternite 8 (Fig. 1I) bare medially, covered with many short and long hairs on each side. Ovipositor valve (Fig. 1I) triangular, rounded posteromedially, thin, membranous, densely covered with microsetae interspersed with 5 or 6 short

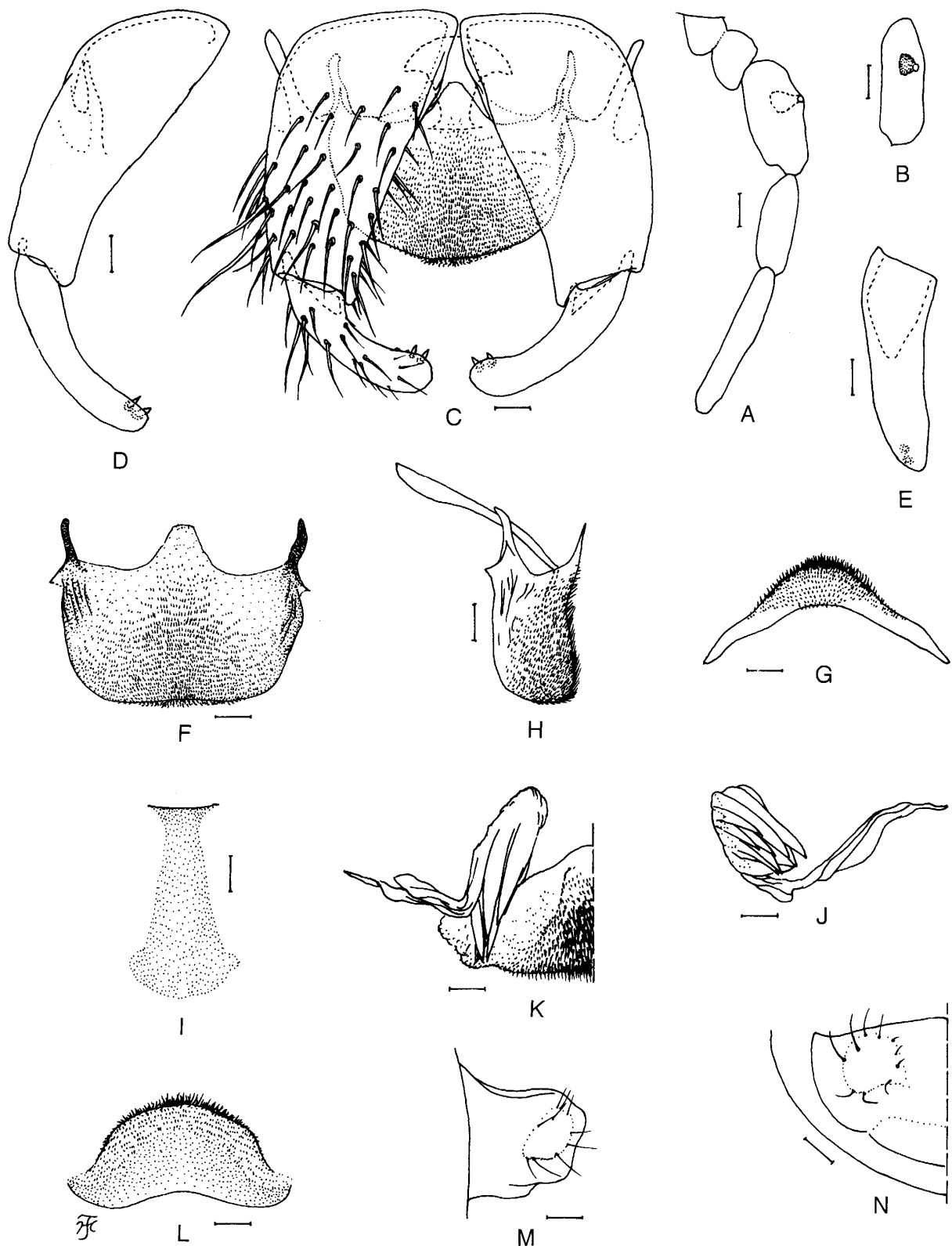


Fig. 2. Male of *Simulium* (*Wallacellum*) *suyoense* sp. nov. A, maxillary palp (right side; lateral view); B, 3rd segment of maxillary palp with sensory vesicle (right side; front view); C, coxites, styles, ventral plate and median sclerite *in situ* (ventral view); D, coxite and style *in situ* (right side; medial view); E, style (right side; ventrolateral view); F and G, ventral plates (F, ventral view; G, end view); H, ventral plate and median sclerite *in situ* (lateral view); I, median sclerite (end view); J, paramere (right side; dorsal view); K, paramere and aedeagal membrane (right half; ventral view); L, aedeagal membrane and dorsal plate (posterodorsal view); M and N, 10th abdominal segments and cerci (M, lateral view; N, end view). Scale bars. 0.03 mm for A and B; 0.02 mm for C–N.

setae; inner margins slightly sinuous, moderately separated from each other. Genital fork (Fig. 1J) inverted-Y-shaped; each arm slender, with moderately-sclerotized triangular projection directed anteriorly. Paraproct (Fig. 1K, L) of usual shape, moderately protruding ventrally, covered with many simple hairs on lateral and ventral surfaces, and with 3 sensilla on anteromedial surface. Cercus (Fig. 1K, L) of usual shape, rounded posteriorly, about 0.5 times as long as wide, and moderately covered with usual simple hairs. Spermatheca (Fig. 1M) nearly globular, well sclerotized except small area at its juncture to main duct unsclerotized, with reticulate surface patterns, and without internal setae; both accessory ducts slender, subequal in diameter to major duct.

Male. Body length 2.3 mm. **Head.** Much wider than thorax. Holoptic. Upper eye consisting of large facets in 14 or 15 vertical columns and in 15 or 16 horizontal rows. Clypeus brownish-black, not shiny, moderately covered with dark simple long hairs. Antenna composed of 2+9 segments, yellow except basal 1/2 of 1st flagellar segment dark brown and a few apical segments somewhat grayish; 1st flagellar segment elongated, 1.7 times as long as 2nd one. Maxillary palp (Fig. 2A) medium brown to brownish-black, with 5 segments, proportional lengths of 3rd, 4th, and 5th segments 1.0 : 0.8 : 1.3; 3rd segment (Fig. 2B) somewhat enlarged; sensory vesicle nearly ellipsoidal in front view, 0.16 times as long as 3rd segment, with small opening. **Thorax.** Scutum medium brown, with 2 darker submedial longitudinal vittae connected to somewhat darker prescutellar area, slightly shiny at certain angle of light, moderately covered with yellow scale-like recumbent short hairs intermixed with dark similar hairs anteriorly and laterally, and with a few dark brown upright usual simple hairs on prescutellar area. Scutellum medium brown, with dark upright usual simple hairs as well as yellow scale-like short hairs. Postnotum medium brown, slightly shiny at certain angle of light, thinly white pruinose, bare. Pleural membrane moderately covered with yellow fine hairs. Katepisternum longer than deep, dark brown, densely covered with dark short hairs. **Legs.** Color and shape (except claws) nearly as in female. Fore basitarsus slightly dilated, 8.3 times as long as its greatest width. Hind basitarsus 6.17 times as long as wide, 0.64 and 0.56 times as wide as

greatest widths of tibia and femur, respectively. **Wing.** Length 2.0–2.1 mm; other characters as in female except subcosta bare. **Abdomen.** Basal scale dark brown, with fringe of golden-yellow long hairs; dorsal surface of abdominal segments dark brown to brownish-black, not shiny and densely covered with golden-yellow scale-like recumbent hairs intermixed with dark similar hairs and dark usual simple hairs; ventral surface of abdomen light brown, moderately covered with dark short hairs. **Genitalia.** Coxite in ventral view (Fig. 2C) subquadrate, 2.1 times as long as wide; coxite in medial view (Fig. 2D) somewhat flattened dorsoventrally. Style in ventral and medial views (Fig. 2C, D) slender, 0.74 times as long as coxite, nearly parallel-sided, gently curved inwardly, with 2 apical spines; style in ventrolateral view (Fig. 2E) slightly narrowed toward apex. Ventral plate in ventral view (Fig. 2C) transverse, wider than long, densely covered with microsetae on ventral surface except small areas along anterior and lateral margins bare; posterior margin in ventral view appearing rounded medially to some extent (Fig. 2C) but appearing to be nearly straight when slightly inclined (Fig. 2F); basal arms short and slender, directed forwardly and somewhat dorsally; ventral plate in posterior view (Fig. 2G) with medial portion moderately produced ventrally, and densely covered with microsetae on posterior surface except both lateral areas bare; ventral plate in lateral view (Fig. 2H) with posterior 1/2 very slightly produced ventrally. Median sclerite (Fig. 2C, H, I) thin, broad and rounded apically. Paramere (Fig. 2J, K) slender, well-sclerotized, with 7 or 8 short to long stout hooks. Aedeagal membrane (Fig. 2K, L) densely covered with spinous microsetae on ventromedial surface but moderately with slender microsetae on posterior and posterodorsal surfaces, and moderately sclerotized along dorsal margin forming wide dorsal plate. Ventral surface of 10th segment (Fig. 2M) without distinct hairs. Cercus (Fig. 2M, N) small, not produced, encircled with 9 or 10 short hairs.

Pupa. Body length (excluding gill filaments) about 2.5 mm. **Head.** Integument light ochreous, bare (without any tubercle); frons with 2 (or 3 in 1 female pupa) pairs of medium-long simple slender trichomes lying along lateral margin and moderately separated from each other (Fig. 3A) on each side; face with pair of short needle-like trichomes (Fig. 3B); antennal

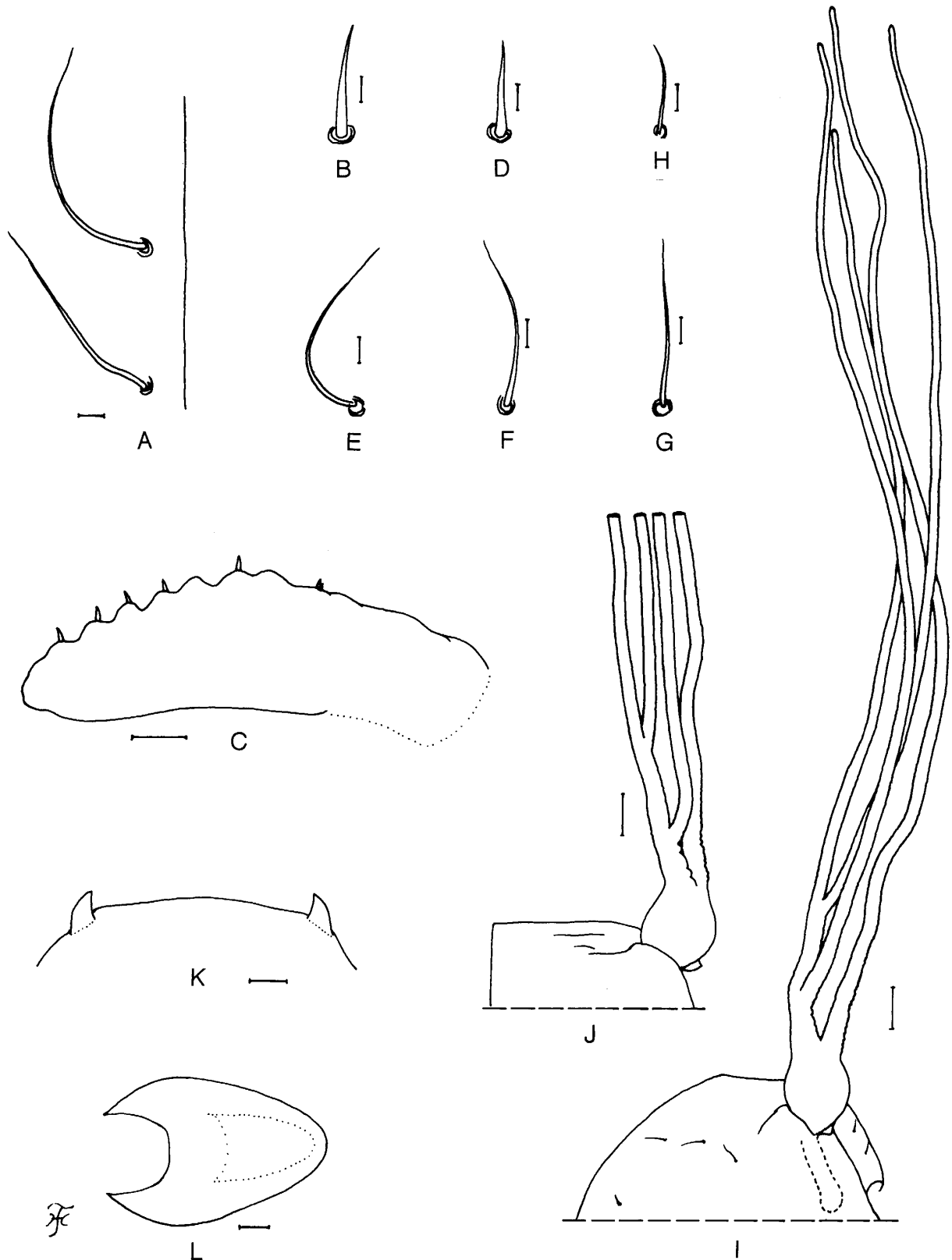


Fig. 3. Pupa of *Simulium* (*Wallacellum*) *suyoense* sp. nov. A, 2 trichomes on frons *in situ* (left side); B, facial trichome; C, antennal sheath showing distinct saw-like spines (right side; outer view); D-H, thoracic trichomes (D and E, mediodorsal; F, anterolateral; G, posterolateral; H, ventrolateral); I and J, gill filaments with anterior part of thorax (right side; I, lateral view; J, dorsal view); K, terminal hooks (dorsal view); L, cocoon (dorsal view). Scale bars. 0.5 mm for L; 0.1 mm for I and J; 0.05 mm for C; 0.02 mm for K; 0.01 mm for A, B and D-H.

sheath (Fig. 3C) with 8 slightly to moderately raised projections, of which 3–7 projections having 1 distinct spine (or rarely 2) directed outward; projections with spine(s) vary in number and site among individual pupae and also between left and right antennal sheaths of the same pupae. **Thorax.** Integument

ocherous, sparsely covered with conical tubercles except anterodorsal surface almost bare; thorax on each side with 9 simple trichomes (3 mediodorsally, 2 anterolaterally, 1 posterolaterally, 3 ventrolaterally) (Fig. 3D–H), 2 of 3 mediodorsal trichomes short, stout and needle-like (Fig. 3D), and 3 ventrolateral ones short (Fig. 3H) while others slender and medium-long (Fig. 3E–G). Gill (Fig. 3I, J) composed of 4 slender filaments arranged in (2+1)+1 filaments; primary stalk of upper triplet filaments and lower individual filament arising from bulbous common basal stalk; secondary stalk of upper triplet subequal to, or shorter or longer than, primary stalk; all filaments light ocherous, subequal in length (2.0–2.5 mm long) and thickness, with well-defined annular ridges and furrows on their surface, and covered with minute tubercles of various sizes, relatively larger ones on ridges and smaller ones on inter-ridge spaces. **Abdomen.** Dorsally, segment 1 weakly sclerotized, ocherous, bare, with 1 or 2 simple short slender setae on each side; segment 2 weakly sclerotized and ocherous on basal 1/4 to 1/2, bare, with 6 very short simple stout spines and 1 short simple slender seta along posterior border on each side; segments 3 and 4 weakly sclerotized and ocherous in form of narrow transverse band along anterior margin, each with 4 hooked spines directed forward and 1 very short simple spinous seta on each side; segment 5 transparent, bare, with a few very short simple setae; segments 6–8 each transparent, with comb-like groups of minute spines directed caudad on each side, and a few very short simple setae; segment 9 weakly sclerotized and ocherous, with pair of distinct conical terminal hooks directed caudad (Fig. 3K) as well as comb-like groups of minute spines directed caudad on each side. Ventrally, segment 3 transparent, with a few simple minute setae; segment 4 transparent, with 1 bifid hook (subequal to or slightly smaller than those on segments 5–7) (usually accompanied by 1 simple hook developed to varying extent) and a few minute setae submedially on each side; segment 5 transparent,

with pair of bifid hooks and a few minute setae on each side; segments 6 and 7 each with 1 bifid inner hook and devoid of outer hook (though 1 bifid outer hook present on right side of segment 6 in 1 pupa), and with a few minute setae on each side; segment 8 almost transparent or very weakly sclerotized, and with a few minute setae; segments 3–8 each with comb-like groups of minute spines directed caudad on each side; segment 9 weakly sclerotized and light ocherous, bare, and without grapnel-like hooklets ventrolaterally. **Cocoon** (Fig. 3L). Simple, wall-pocket-shaped, thinly woven, and extending ventrolaterally; anterior margin moderately woven and well defined; individual threads visible or invisible; floor present on posterior 1/2; 3.0–3.5 mm long by 2.0–2.4 mm wide.

Mature larva. Body length 4.8–5.0 mm. Body (Fig. 8A,B) normal in shape, somewhat swollen on thoracic segments, narrow on abdominal segments 1–4 (though slightly larger posteriorly), swollen from segment 5 to segment 6, and narrowed toward posterior end; body color white except ventral surface of thorax partially or almost entirely light grayish-green (in all 5 larvae examined), and also dorsal surface of abdominal segment 6 (in 2 larvae) or segments 6–9 (in 2 larvae) or segments 3–9 (in 1 larva) light grayish-green; thorax with reddish-brown speckles laterally on each side of segment 1 (only in 1 larva); abdomen with reddish-brown speckles in transverse line laterally on each side of segments 1–4, dorsolaterally on each side of segment 5 (only 1 larva), ventrolaterally on each side of segment 6, and with reddish-brown speckles in longitudinal line medially on ventral surface of segments 5 and 6, and with similar colored speckles to varying extents submedially on dorsal surface of segments 6–8. Head capsule (Fig. 8D, F) almost white to yellowish-white though posterior 3/4 of ventral surface of 1 larva darkened; head-spots indiscernible or very faintly positive. Cervical sclerite composed of 2 small narrow rod-like pieces, not fused to occiput, widely separated medially from each other. Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; proportional lengths of 3 segments from base to tip 1.00:1.00:1.01. Labral fan with about 44 main rays; dorsal-most ray (Fig. 4A) having different pectination from that of other main rays (Fig. 4B). Mandi-

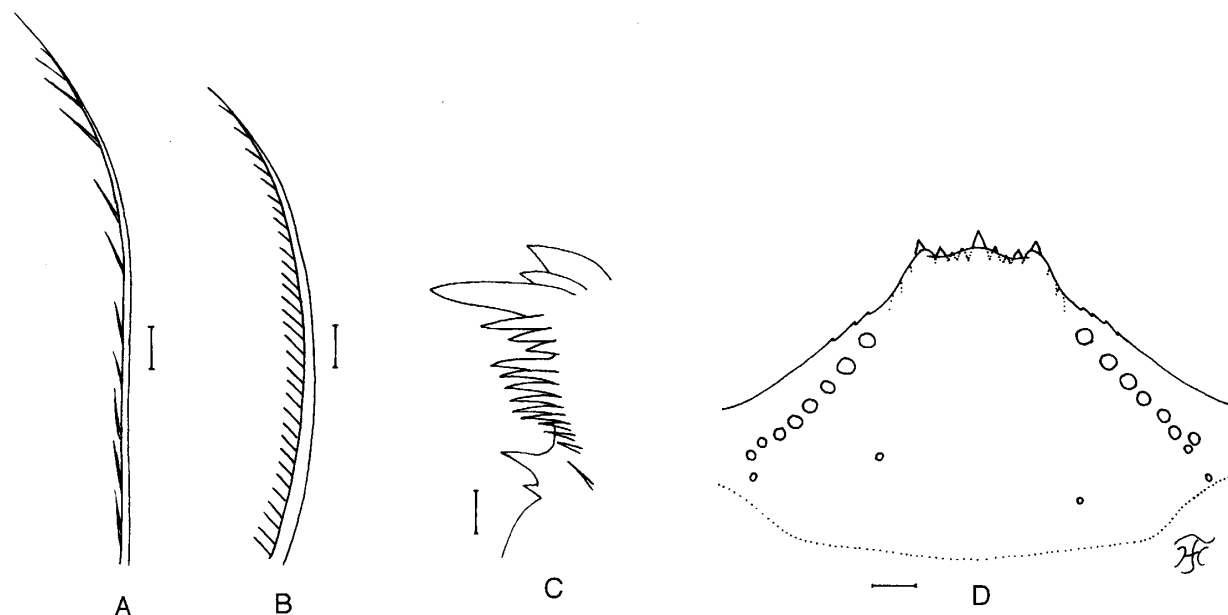


Fig. 4. Mature larva of *Simulium* (*Wallacellum*) *suyoense* sp. nov. A, dorsalmost main ray of labral fan (apical 1/2); B, usual main ray of labral fan (apical 2/5); C, mandible; D, hypostoma. Scale bars. 0.02 mm for A, B and D; 0.01 mm for C.

ble (Fig. 4C) with comb-teeth decreasing in size from 1st to 3rd; mandibular serrations composed of 2 teeth (1 large, 1 small); large tooth at right angle to the mandible on apical side; supernumerary serrations absent. Hypostoma (Fig. 4D) with 9 apical teeth in row; median tooth slightly longer than each corner tooth; median tooth of 3 intermediate teeth on each side shortest; lateral margin serrate; 8 or 9 hypostomal bristles per side, lying slightly diverging posteriorly from lateral margin. Postgenal cleft (Fig. 8F) hanging-bell-shaped, with narrow anteromedian extension, about 1.6 times as long as postgenal bridge. Thoracic cuticle bare. Abdominal cuticle almost bare except each side of anal sclerite of last segment moderately covered with simple colorless setae. Rectal scales absent. Rectal organ simple, each of 3 lobes without secondary lobules. Anal sclerite X-shaped, with anterior arms somewhat broadened, and nearly as long as, or slightly shorter than, posterior ones; basal juncture area with narrow deep unsclerotized median incision posteriorly; no sensilla on basal juncture area, and several sensilla behind posterior arms; accessory sclerite absent. Last abdominal segment expanded ventrolaterally forming large ventrolateral bulge and smaller ventral bulge on each side, the latter visible as small ventral papilla when viewed from side; ventrolateral

bulge sparsely covered with minute colorless setae. Posterior circlet with about 108 rows of up to 18 hooklets per row.

TYPE SPECIMENS. Holotype female (with its associated pupal exuviae and cocoon), reared from a pupa, collected from a small stream (width 0.3–1.0 m, depth 2–5 cm, streambed rocky, exposed to sun, water temperature 25.5°C, altitude 250 m), Barangay Ursadan, Suyo, Ilocos Sur Province, Luzon Island, Philippines, 19.II.2005, by H. Takaoka. Paratypes: 4 females, 1 male (all adults reared from pupae), 4 pupae and 3 mature larvae, same data as those of holotype.

ECOLOGICAL NOTES. The pupae and larvae of this new species were taken from dead leaves in a slow-flowing stream. Associated species were *S. (Gomphostilbia) banauense* Takaoka, *S. (G.) liliwense* Takaoka, *S. (W.) claveriaense* sp. nov. and *S. (W.) tuyense* Takaoka.

ETYMOLOGY. The species name *suyoense* refers to the name of the locality, Suyo, where this new species was collected.

REMARKS. This new species seems to be closely related to *S. (W.) alfuense* Takaoka from Seram Island (Takaoka, 2003), *S. (W.) celebesense* Takaoka from Sulawesi Island (Takaoka, 2003), *S. (W.) tuyense* from Luzon Island (Takaoka, 1983) and *S. (W.) yonakuniense* Takaoka from the Ryukyu Islands (Takaoka, 1972), since there are many characteristics shared by all these species including the enlarged female sensory vesicle, the flat ventral plate with rounded posterior margin, the elongated calcipala reaching the apical tip of the second tarsal segment, the pupal antennal sheath with saw-like spines, the pupal gill with four slender thread-like filaments, and simple wall-pocket-shaped cocoon. However, *S. (W.) suyoense* sp. nov. is easily distinguished from these known species in the female and male by the hind tibia with a more elongated low process extending along its shaft from the base to the midpoint on its anteromedial surface (Fig. 1E), in the female by the genital fork lacking a lobe directed posteromedially on each arm (Fig. 1J), in the male by the larger number of the enlarged eye-facets, in the pupa by the gill with (2+1)+1 filaments arising from a bulbous base (Fig. 3I) and in the larva by the almost entirely pale cephalic apotome (Fig. 8D).

It is intriguing that the male of *S. (W.) suyoense* sp. nov. has two apical spines on each style (Fig. 2C) (in place of one spine), a character thus far never being encountered among the subgenus *Wallacellum*. However, more male specimens should be examined to determine whether this character is always found in this species or not.

***Simulium (Wallacellum) claveriaense*
sp. nov.**

DESCRIPTION. Female. Body length 2.3–2.5 mm. **Head.** Nearly as wide as thorax. Frons brownish-black, not shiny, densely covered with white scale-like recumbent hairs interspersed with dark longer usual simple hairs; frontal ratio 1.31 : 1.00 : 1.24; frons-head ratio

1.00 : 3.82. Fronto-ocular area (Fig. 5A) moderately developed, narrowed laterally. Clypeus brownish-black, not shiny, densely covered with white scale-like recumbent hairs interspersed with dark longer usual simple hairs. Labrum 0.71 times as long as clypeus. Antenna composed of 2+9 segments, yellow or dark yellow except apical 4 or 5 flagellar segments somewhat darker; 1st flagellar segment 1.61 times as long as 2nd one. Maxillary palp composed of 5 segments, medium brown to brownish-black, proportional lengths of 3rd, 4th, and 5th segments 1.00 : 0.85 : 1.28; 3rd segment (Fig. 5B, C) somewhat enlarged; sensory vesicle ellipsoidal, 0.26 times as long as 3rd segment, with large opening medially. Lacinia with 9 or 10 inner and 11–13 outer teeth. Mandible with 14 teeth on inner margin and smooth on outer margin. Cibarium simple, without any tubercle. **Thorax.** Scutum light brown except each shoulder, narrow area along each lateral margin, and prescutellar area dark brown, with 3 medium to dark brown longitudinal vittae (1 medial, 2 submedial), all connected posteriorly to dark brown prescutellar area and 2 submedial vittae each connected anteriorly to dark brown triangular spot on each shoulder, slightly shiny at certain angle of light, moderately or densely covered with yellowish-white scale-like recumbent short hairs interspersed with dark brown short hairs, and long upright simple hairs on prescutellar area. Scutellum medium to dark brown, with dark brown upright usual simple hairs as well as yellowish-white scale-like short hairs. Postnotum light to medium brown, not shiny and bare. Pleural membrane densely covered with yellowish-white fine hairs interspersed with a few dark brown hairs. Katepisternum longer than deep, densely covered with dark short hairs. **Legs.** Foreleg: coxa, trochanter and femur medium to dark brown with apical cap of femur brownish-black; tibia dark brown with base very narrowly pale; tarsus dark brown, with dorsal crest of short hairs moderately developed on segments 1–3; basitarsus slightly dilated, 7.8 times as long as its greatest width. Midleg: coxa medium brown; trochanter whitish-yellow to light brown; femur whitish-yellow with apical cap dark brown and with light to medium brown broad band medially; tibia dark brown except base narrowly whitish-yellow, and with whitish-yellow narrow band submedially (usually only on

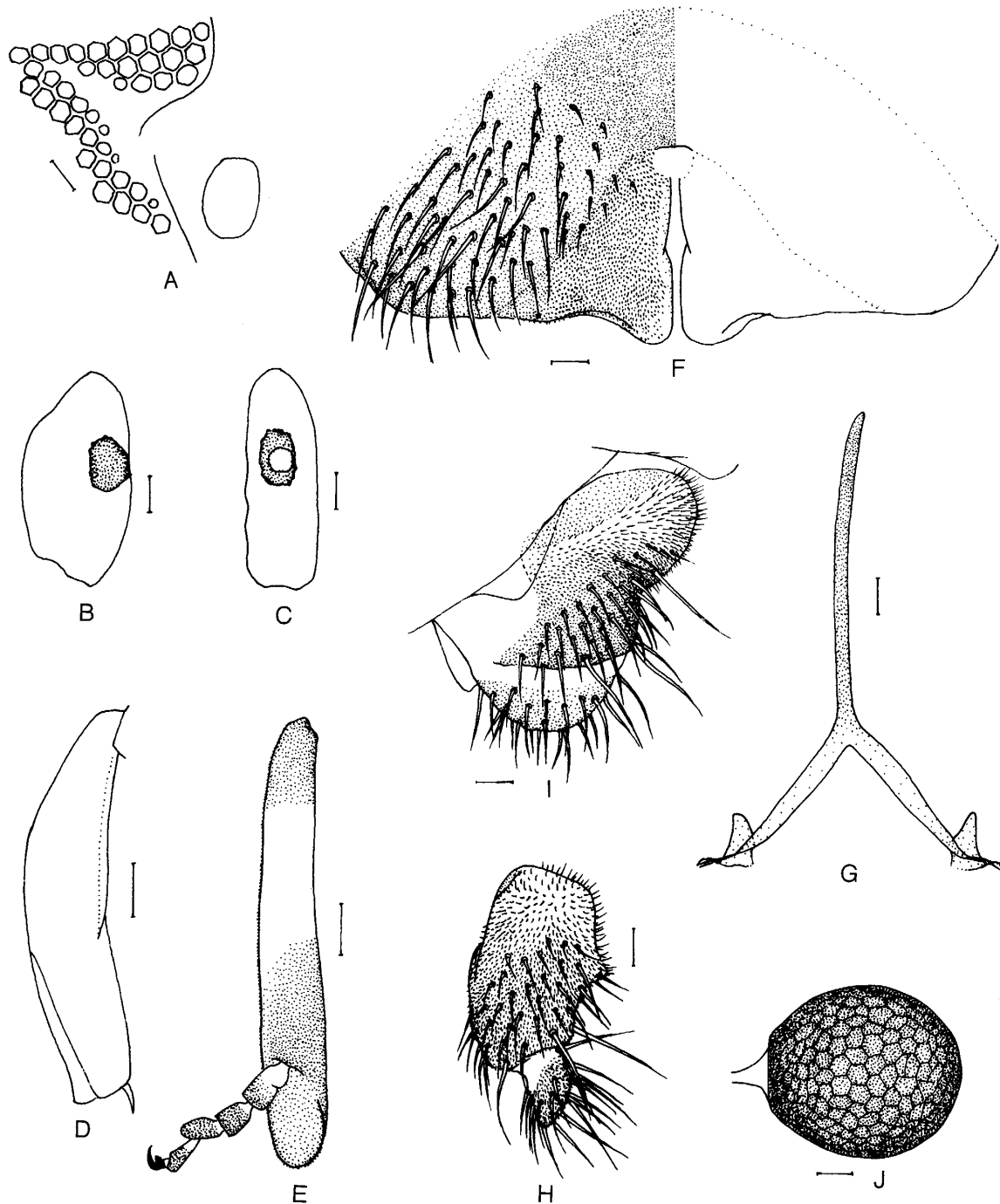


Fig. 5. Female of *Simulium* (*Wallacellum*) *claveriaense* sp. nov. A, fronto-ocular area (right side); B and C, 3rd segments of maxillary palp with sensory vesicle (right side; B, lateral view; C, front view); D, tibia showing a narrowly-constricted low process on its anteromedial surface (left side; inner view); E, hind tarsus showing calcipala, pedisulcus and claw (left side; outer view); F, 8th sternite and ovipositor valves *in situ* (ventral view); G, genital fork (ventral view); H and I, paraprocts and cerci (right side; H, ventral view; I, lateral view); J, spermatheca. Scale bars. 0.1 mm for D and E; 0.03 mm for A–C; 0.02 mm for F–J.

outer surface); tarsus entirely dark brown. Hind leg: coxa light brown; trochanter whitish-yellow except anterior surface light brown; femur whitish-yellow except apical cap dark brown (though widely pale on inner surface);

tibia dark brown except base narrowly whitish-yellow, and with whitish-yellow band submedially (usually only on outer surface); tibia (Fig. 5D) with narrowly-constricted low process on anterointernal surface along basal

3/5 of shaft; this process covered with numerous small spear-shaped spinous scales, elaborately arranged on its surface; tarsus (Fig. 5E) dark brown except submedial wide area of basitarsus, basal 1/2 of 2nd segment and bases of 3rd to 5th segments yellowish-white; basitarsus slender, very slightly widened toward apex, 5.58 times as long as its greatest width, 0.79 and 0.61 times as wide as greatest widths of tibia and femur, respectively; saw-like anterior margin of basitarsus curved inward before reaching to basal apex; basitarsus furnished with numerous slender hairs all over but without any spine on outer surface (though numerous spines present near base on inside surface); calcipala (Fig. 5E) very greatly enlarged, extending to apical end of 3rd tarsal segment, and nearly as wide as apical portion of basitarsus; pedisulcus (Fig. 5E) well developed at basal 1/3 of 2nd tarsal segment. All femora, tibiae and parts of tarsus covered with scale-like hairs as well as usual simple hairs on outer surface. All claws (Fig. 5E) with large basal tooth 0.51 times as long as claw. **Wing.** Length 2.2–2.4 mm. Other characters as in female of *S. (W.) suyoense* sp. nov. **Abdomen.** Nearly as in female of *S. (W.) suyoense* sp. nov. except dorsal surface dark brown to brownish-black. **Genitalia.** Sternite 8 (Fig. 5F) bare medially, covered with 50–56 short to long hairs on each side. Ovipositor valve (Fig. 5F) triangular, rounded posteromedially, thin, membranous though weakly sclerotized along inner margin, densely covered with microsetae interspersed with 1 or 2 short setae; inner margins slightly concave medially, lying close to each other. Genital fork (Fig. 5G) inverted-Y-shaped; each arm slender, with moderately-sclerotized large projection directed anteriorly. Paraproct in ventral view (Fig. 5H) subquadrate, neatly covered with microsetae on weakly sclerotized anterior 1/3, and also covered with many short to long hairs as well as numerous microsetae on more strongly sclerotized posterior 2/3; paraproct in lateral view (Fig. 5I) roundly produced anteroventrally, with bare sclerotized portion narrowly on outer surface along anterior margin; paraproct with 4 or 5 sensilla on anteromedial surface. Cercus in lateral view (Fig. 5I) rounded posteriorly, 0.42 times as long as wide, and moderately covered with dark simple hairs. Spermatheca (Fig. 5J) ovoid, well sclerotized except small area at its juncture to main duct unsclerotized, with reticulate sur-

face pattern, and without internal setae; both accessory ducts slender, subequal in diameter to each other, and to major duct.

Male. Body length 2.4–2.6 mm. **Head.** Much wider than thorax. Holoptic. Upper eye consisting of large facets in 14 vertical columns and in 13 or 14 horizontal rows. Clypeus brownish-black, not shiny, moderately covered with dark simple long hairs. Antenna composed of 2+9 segments, yellow except basal 1/2 of 1st flagellar segment dark brown; 1st flagellar segment elongate, about 2.0 times as long as 2nd one. Maxillary palp medium brown to brownish-black, with 5 segments, proportional lengths of 3rd, 4th, and 5th segments 1.00 : 0.86 : 1.45; 3rd segment (Fig. 6A, B) somewhat enlarged; sensory vesicle nearly globular, 0.17 times as long as 3rd segment, with small opening. **Thorax.** Scutum nearly as in female except recumbent short hairs golden-yellow, and 3 longitudinal vittae barely visible or almost absent. Scutellum medium brown, with dark upright usual simple hairs as well as yellow scale-like short hairs. Postnotum light brown, slightly shiny at certain angle of light, thinly white pruinose, bare. Pleural membrane and katepisternum as in female. **Legs.** Foreleg: coxa, trochanter and femur light brown except apical cap of femur medium brown; tibia medium brown with base very narrowly pale, and median large area of outer surface light brown; tarsus medium to dark brown, with dorsal crest of short hairs moderately developed on segments 1–3; basitarsus slightly dilated, 8.1 times as long as its greatest width. Midleg: coxa medium brown; trochanter light ochereous; femur light ochereous with apical cap dark brown and with faint light brown broad band medially; tibia medium to dark brown except base narrowly light ochereous, and with ochereous narrow band submedially; tarsus entirely dark brown. Hind leg: coxa light brown; trochanter and femur light ochereous except apical cap of femur medium to dark brown (though widely pale on inner surface of femur); tibia medium to dark brown except base narrowly light ochereous, and with ochereous band submedially; tibia with narrowly-constricted low process on anterointernal surface along a little more than basal 1/2 of shaft (similar to that of female); tarsus medium to dark brown except submedial wide area of basitarsus and basal 1/2 of 2nd segment yellowish-white; basitarsus similar in shape to that of female

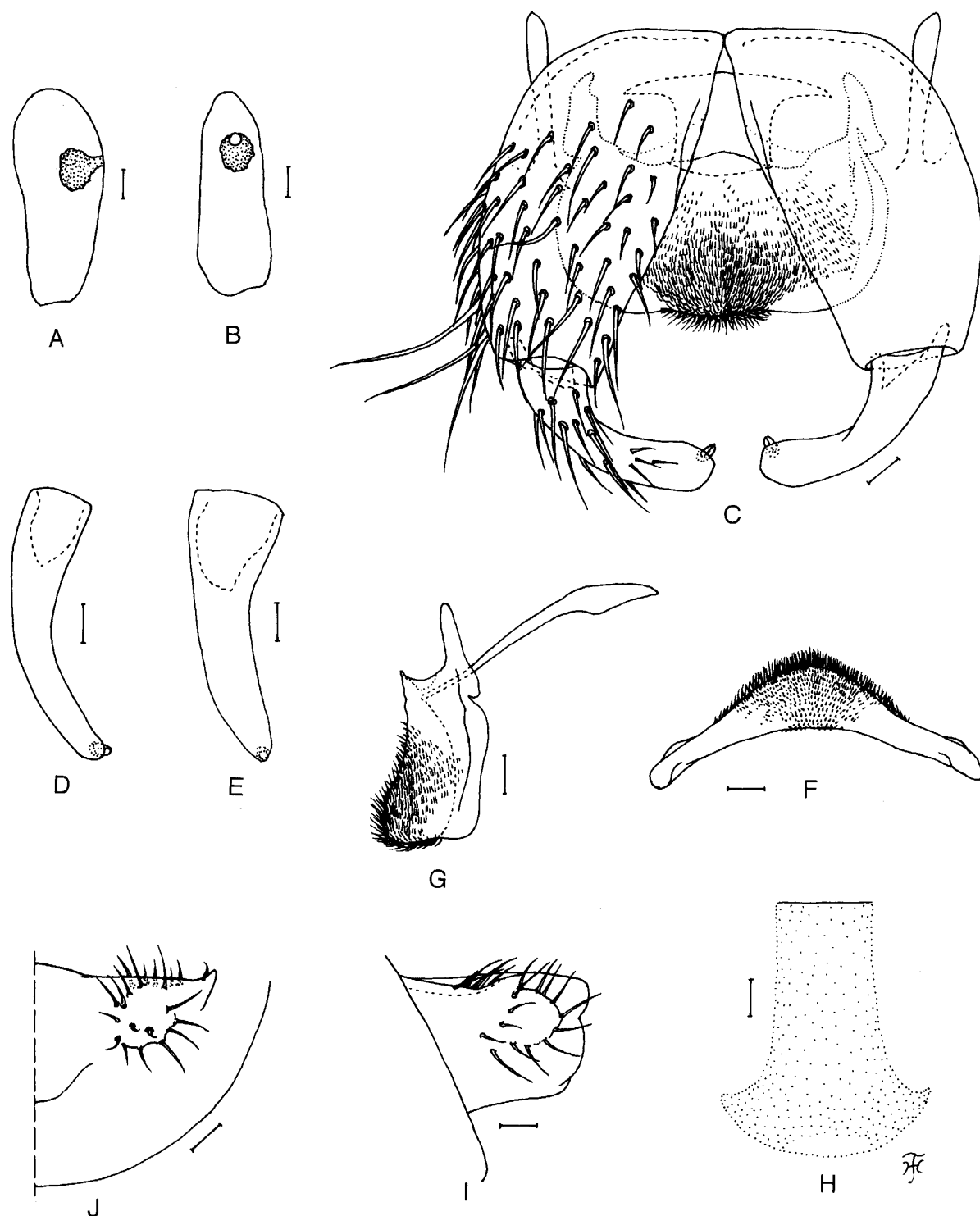


Fig. 6. Male of *Simulium* (*Wallacellum*) *claveriaense* sp. nov. A and B, 3rd segments of maxillary palp with sensory vesicle (right side; A, lateral view; B, front view); C, coxites, styles, ventral plate and median sclerite *in situ* (ventral view); D and E, styles (right side; D, medial view; E, ventrolateral view); F, ventral plate (end view); G, ventral plate and median sclerite *in situ* (lateral view); H, median sclerite (end view); I and J, 10th abdominal segments and cerci (I, lateral view; J, end view). Scale bars. 0.02 mm for A-J.

though almost parallel-sided; calcipala and pedisulcus also similar to those of female; basitarsus 6.33 times as long as wide, 0.63 and

0.54 times as wide as greatest widths of tibia and femur, respectively. **Wing.** Length 2.0–2.1 mm; other characters as in female except sub-

costa bare. **Abdomen.** Basal scale dark brown, with fringe of pale long hairs; dorsal surface of abdominal segments dark brown, not shiny, and densely covered with yellow scale-like recumbent hairs intermixed with dark similar hairs and dark usual simple hairs; ventral surface of abdomen light brown, moderately covered with dark short hairs. **Genitalia.** Coxite in ventral view (Fig. 6C) subquadrate, 1.9 times as long as wide; coxite in medial view somewhat flattened dorsoventrally. Style in ventral view (Fig. 6C) slender, nearly parallel-sided, gently curved inwardly, with 1 apical spine having slit medially; style in medial view (Fig. 6D) gradually narrowed from base to apex, and gently curved inwards; style in posterolateral view (Fig. 6E) narrowed from base to basal 1/3, then nearly parallel-sided, and tapered from apical 1/4 to apex, 2.94 times as long as its greatest width at base, and 0.76 times as long as coxite. Ventral plate in ventral view (Fig. 6C) transverse, wider than long, densely covered with microsetae on ventral surface except small areas along anterior and lateral margins bare; anterior margin weakly defined medially; and lateral margins gently rounded; basal arms short and of moderate width, directed forward; ventral plate in posterior view (Fig. 6F) with medial portion moderately produced ventrally, and densely covered with microsetae centrally on posterior surface; ventral plate in lateral view (Fig. 6G) with posterior 1/2 very slightly produced ventrally. Median sclerite (Fig. 6G, H) thin, very broad and rounded apically. Paramere and aedeagal membrane including dorsal plate similar to those of *S. (W.) suyoense* sp. nov. Ventral surface of 10th segment (Fig. 6I, J) with 6 short hairs on each side. Cercus (Fig. 6I, J) small, not produced, encircled with 14 or 15 short hairs.

Pupa. Body length (excluding gill filaments) about 3.0 mm. **Head.** Integument (Fig. 7A) light ochereous, bare except small raised area with several small tubercles just below facial trichome on each side: frons with 3 (or rarely 4 in left side of 1 female pupa) very long branched (split into 4–6 branches) trichomes lying along lateral margin and moderately separated from one another on each side; face with 1 very long branched (split into 4 or 5 branches) trichome on each side; antennal sheath without any projection, and bare. **Thorax.** Integument light ochereous to medium brown, widely bare except posterior 1/4 moderately covered with

small conical tubercles on dorsal surface; thorax on each side with 2 simple long trichomes (Fig. 7B) mediodorsally, 2 simple trichomes (1 long, 1 medium-long or long) (Fig. 7C, D) anterolaterally, 1 simple long trichome (Fig. 7E) posterolaterally, 3 simple trichomes (1 very long, 1 long or medium-long, 1 medium-long) (Fig. 7F–H) ventrolaterally. Gill (Fig. 7I) composed of 4 short slender but stout filaments arranged in pairs; upper filament of dorsal pair first directed upward and forward, then forward, lower filament slightly directed upward and forward, then forward, while 2 filaments of ventral pair first directed outward and forward to some extent, then forward; both pairs very short-stalked or almost sessile and arising at base; all filaments dark brown, tapered toward apex, with numerous well-defined annular ridges and furrows at very short intervals on their surface, and densely covered with minute tubercles of various sizes, relatively larger ones on ridges and smaller ones on interridge spaces; 2 filaments of each pair subequal in length and thickness to each other, or lower filament of dorsal pair and upper filament of ventral pair slightly longer than their counter filaments; 2 filaments of ventral pair (1.4–1.7 mm long) somewhat longer and very slightly thicker than those of dorsal pair (0.9–1.2 mm long). **Abdomen.** Dorsally, segment 1 weakly sclerotized, ochereous, bare, with 1 simple short slender seta on each side; segment 2 weakly sclerotized and ochereous on basal 1/2, bare, with 5 (or 6) very short simple spinous setae and 1 short simple slender seta along posterior border on each side; segment 3 weakly sclerotized and light ochereous in form of narrow transverse band along anterior margin; segments 3 and 4 each with 4 hooked spines directed forward and 1 very short simple spinous seta on each side; segments 5–9 nearly transparent, densely covered with comb-like groups of minute spines directed posteriorly on entire surface (except segment 5 sparsely covered) and a few very short simple setae on each side; segment 9 with pair of distinct conical terminal hooks directed posteriorly. Ventrally, segment 3 transparent, with a few simple minute setae; segment 4 transparent, with 1 bifid hook (slightly smaller than those on segments 5–7) and a few minute setae submedially on each side; segment 5 transparent, with pair of bifid hooks and a few minute setae on each side; segments 6 and 7 each with 1 bifid inner

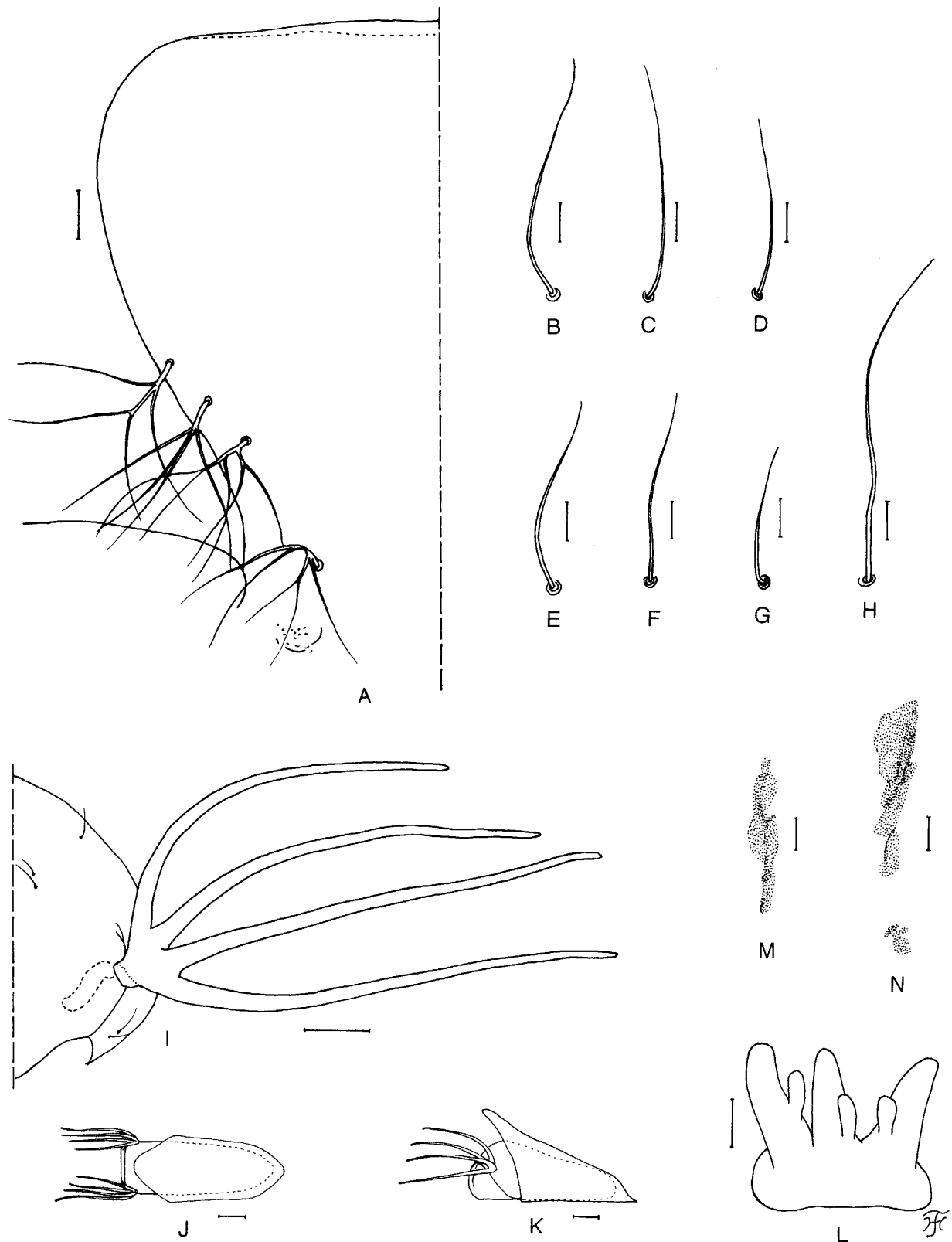


Fig. 7. Pupa and mature larva of *Simulium (Wallacellum) claveriaense* sp. nov. A-K, pupa; L-N, larva. A, frons and upper part of face showing 3 frontal and 1 facial branched trichomes, and small raised area below facial trichome (right half); B-H, thoracic trichomes (B, mediodorsal; C and D, anterolateral; E, posterolateral; F-H, ventrolateral); I, gill filaments with anterior part of thorax (right side; lateral view); J and K, cocoons and pupae (J, dorsal view; K, lateral view); L, rectal organ (posterodorsal view); M and N, accessory sclerites. Scale bars. 0.5 mm for J and K; 0.2 mm for I; 0.1 mm for L; 0.05 mm for A; 0.01 mm for B-H, M and N.

hook and devoid of outer hook, and with a few minute setae on each side; segment 8 almost transparent, and with a few minute setae; segments 3–8 each with comb-like groups of minute spines directed posteriorly on each side; segment 9 bare and without grapnel-like hooklets ventrolaterally. **Cocoon** (Fig. 7J, K). Wall-pocket-shaped, thickly woven, medium to dark brown, short ventrolaterally, produced anterodorsally like eaves far beyond anterior tip of ventrolateral margins, and covering posterior 2/3 of pupal body laterally; individual threads visible; 2.5–2.8 mm long by 2.2–2.4 mm wide, anterodorsal projection about 1.5 mm high; floor moderately woven, about 2.0 mm long.

Mature larva. Body length 6.5–6.9 mm. Body (Fig. 8C) normal in shape, similar to that of *S. (W.) suyoense* sp. nov.; thorax and abdominal segments 1 and 2 almost entirely dark grayish or bruish-gray, and other abdominal segments dark grayish or bruish-gray only dorsally; all abdominal segments mottled with reddish-brown spots to varying extents dorsally and/or dorsolaterally (also ventrally on segments 1 and 2). Cephalic apotome (Fig. 8E) almost entirely white or very slightly to slightly darkened except narrow area along each lateral margin, and with dark brown narrow area along posterior margin; all head spots dark brown, well defined. Head capsule in lateral view light to medium brown dorsal to and posterior to eye-spot region (also slightly darkened ventral to eye-spot region in some larvae), with 2 large and 2 small dark brown spots in front of posterior margin, and 1 small dark brown spot ventral to eye-spot region. Head capsule in ventral view (Fig. 8G) slightly darkened except narrow area along posterior margin of hypostoma pale, and median area on both sides of postgenal cleft much darkened, with 1 horizontal long and 1 round dark brown spots on each side of postgenal cleft. Cervical sclerite (Fig. 8E) composed of 1 narrow rod-like piece on each side, not fused to occiput, widely separated medially from each other. Antenna composed of 3 segments and apical sensillum, longer than stem of labral fan; proportional lengths of 3 segments from base to tip 1.0 : 1.0 : 0.9. Labral fan with 46–50 main rays; dorsal-most ray having different pectination from that of other main rays, similar to that of *S. (W.) suyoense* sp. nov. Mandible and hypostoma as those of *S. (W.) suyoense* sp. nov. Postgenal

cleft (Fig. 8G) hanging-bell-shaped, with narrow anteromedian extension, and 1.2–1.3 times as long as postgenal bridge. Thoracic cuticle bare. Abdominal cuticle almost bare except each side of anal sclerite of last segment moderately covered with colorless setae. Rectal scales present. Rectal organ (Fig. 7L) compound, each of 3 lobes with 0–2 small short thumb-like or finger-like secondary lobules. Anal sclerite X-shaped, with anterior arms somewhat broadened, and nearly as long as, or slightly longer than, posterior ones; basal juncture area with narrow deep unsclerotized median incision posteriorly; 1 sensillum on unsclerotized median incision, and a few sensilla behind posterior arms; accessory sclerite (Fig. 7M, N) present in form of light brown streak composed of 1 or 2 groups of small plates just before posterior circlet on each lateral side. Last abdominal segment expanded ventrolaterally forming large ventrolateral bulge and smaller ventral bulge on each side, the latter visible as small ventral papilla when viewed from side; larger bulge sparsely covered with colorless minute setae. Posterior circlet with 128–134 rows of up to 20 hooklets per row.

TYPE SPECIMENS. Holotype female (with its associated pupal exuviae), reared from a pupa, collected from a small stream (width 10–50 cm, depth less than 1 cm, bottom rocky, current slow or moderate, water temperature 24.0°C, shaded, altitude about 40 m) along the national road from Cagayan Province westward to Ilocos Norte Province, Claveria, Cagayan Province, Luzon Island, Philippines, 18.II.2005, by H. Takaoka. Paratypes: 2 females, 4 males (all adults reared from pupae), and 8 mature larvae, same data and date as those of the holotype; 1 female (reared from a pupa), 1 pupal exuviae and 4 mature larvae, Suyo, Ilocos Sur Province, same data and date as those of the holotype of *S. (W.) suyoense* sp. nov.; 1 male (reared from a pupa), and 1 pupa, collected from a small slow-flowing shallow stream (width 0.5–1.0 m, bottom rocky, partially shaded, altitude 490 m), near Marcos Highway, Palina, Tuba, Benquet Province, 20.I. 2001, by H. Takaoka.

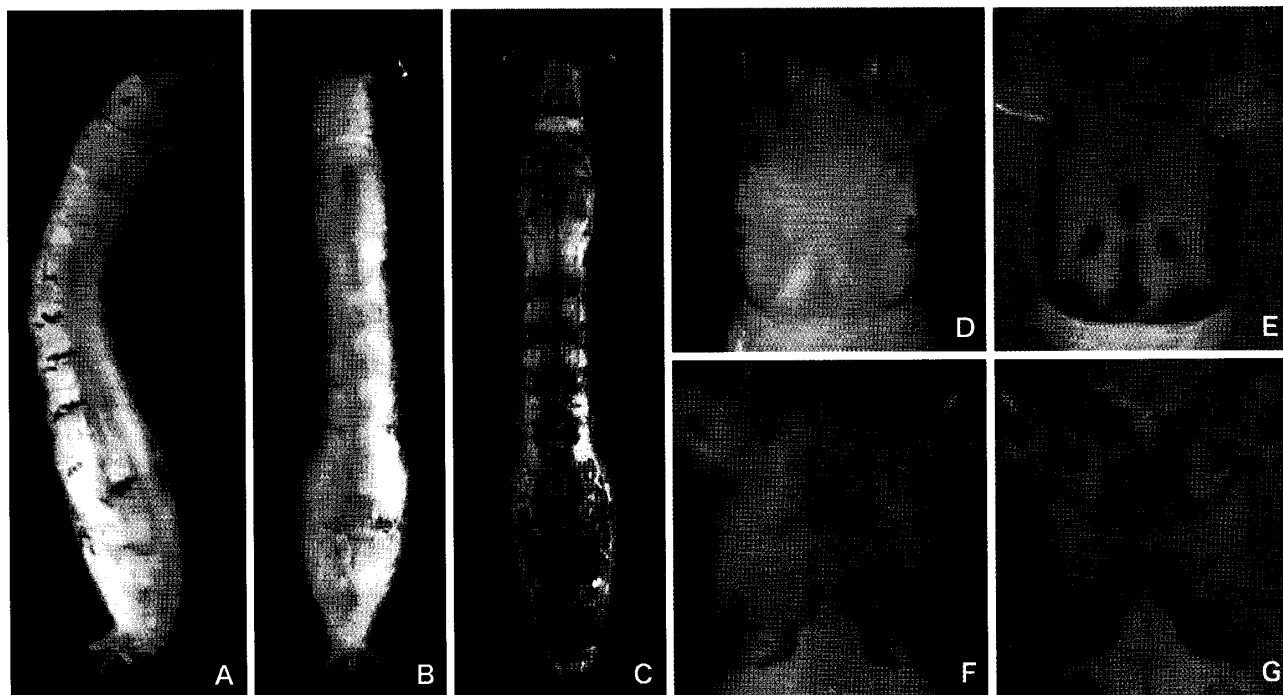


Fig. 8. Mature larvae of two new species of *Simulium* (*Wallacellum*). A-C, whole bodies (A, lateral view; B and C, dorsal view); D-G, head capsules (D and E, dorsal view showing cephalic apotome; F and G, ventral view showing postgenal cleft). A, B, D and F, *S. (W.) suyoense* sp. nov.; C, E and G, *S. (W.) claveriaense* sp. nov.

ECOLOGICAL NOTES. The pupae and larvae of this new species were collected from fallen tree leaves in a small cascading stream at Claveria, together with *S. (G.) cagayanense* Takaoka, *S. (G.) luzonicum* Takaoka, *S. (W.) cabrerai* Takaoka, *S. (W.) recurvum* Takaoka, from leaves of trailing grasses in a stream at Suyo, Ilocos Sur Province, together with *S. (G.) banauense*, *S. (G.) liliwense*, *S. (W.) suyoense* sp. nov. and *S. (W.) tuyense*, and from fine grass roots in a stream at Palina, Benquest Province, together with *S. (G.) baisasae*, *S. (S.) baltazarae* Delfinado, *S. (W.) recurvum* and *S. (W.) tuyense*.

ETYMOLOGY. The species name *claveriaense* refers to the type locality, Claveria, where this new species was collected.

REMARKS. This new species seems to be most closely related to *S. (W.) makilingense* Takaoka described from Mt. Makiling, Laguna Province, Luzon Island (Takaoka, 1983), because both species share

many characteristics including the genitalia of both sexes, three pairs of branched trichomes on the pupal frons (Fig. 7A) and the wall-pocket-shaped cocoon with an eaves-like anterodorsal projection (Fig. 7J, K) (though the anterodorsal projection of the cocoon is very short in *S. (W.) makilingense*). However, this new species is easily distinguished from *S. (W.) makilingense* by the short pupal gill filaments (Fig. 7I), and from all the other known species of this subgenus by the cocoon of this peculiar shape (Fig. 7J, K).

***Simulium (Wallacellum) molawinense*
sp. nov.**

DESCRIPTION. Male. Body length 2.3 mm. **Head.** Much wider than thorax. Holoptic. Upper eye consisting of large facets in 15 vertical columns and in 15 horizontal rows. Clypeus dark brown, not shiny, moderately covered with dark simple long hairs interspersed with several yellow shorter hairs except median longitudinal portion bare on lower 3/4. Antenna composed of 2+9 seg-

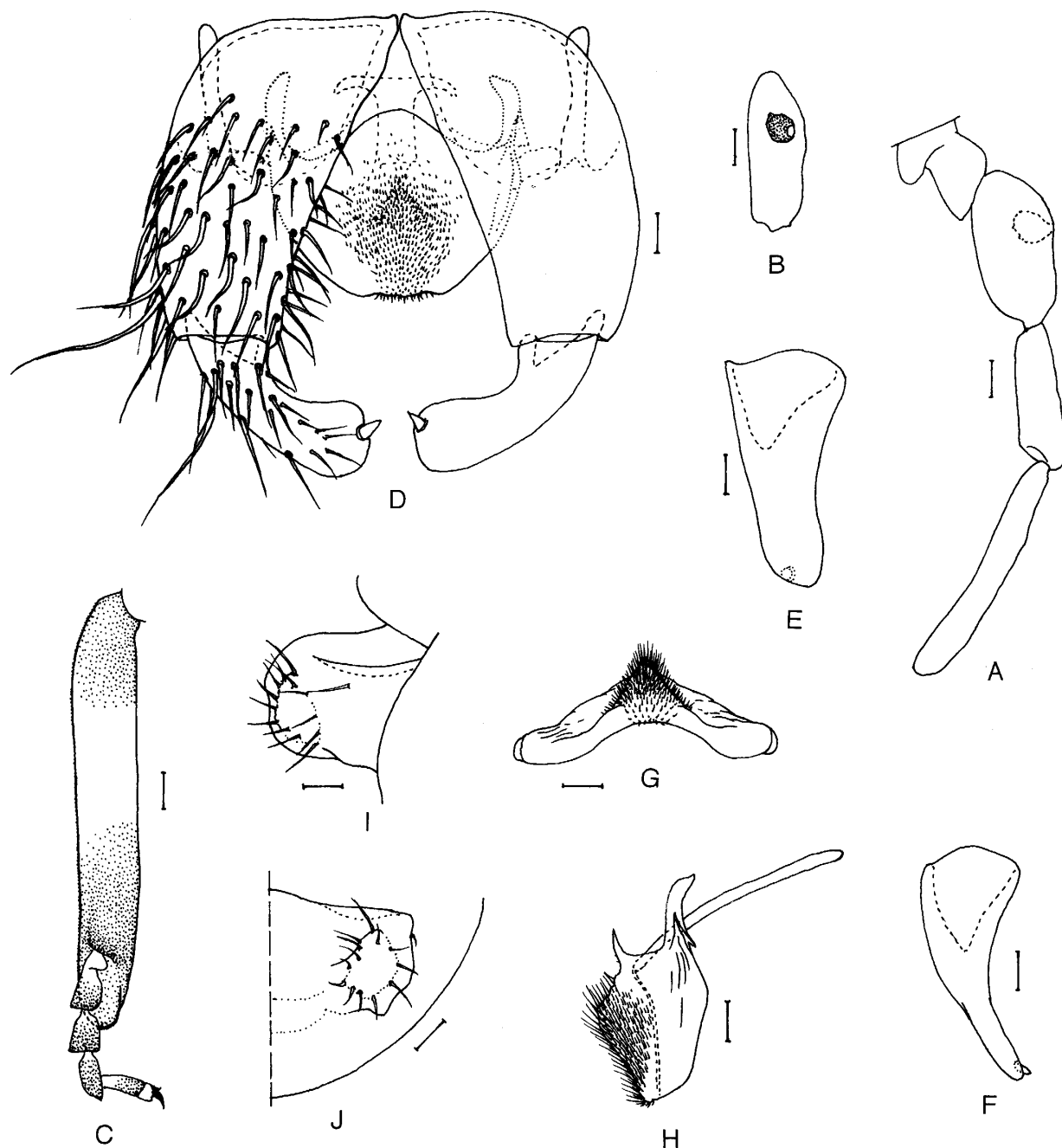


Fig. 9. Male of *Simulium* (*Wallacellum*) *molawinense* sp. nov. A, maxillary palp (right side; lateral view); B, 3rd segment of maxillary palp with sensory vesicle (right side; front view); C, hind tarsus showing calcipala and pedisulcus (left side; outer view); D, coxites, styles, ventral plate and median sclerite *in situ* (ventral view); E and F, styles (right side; E, ventrolateral view; F, posteroventral view); G, ventral plate (end view); H, ventral plate and median sclerite *in situ* (lateral view); I and J, 10th abdominal segments and cerci (I, lateral view; J, end view). Scale bars. 0.05 mm for C; 0.03 mm for A and B; 0.02 mm for D–J.

ments, yellow except basal 1/2 of 1st flagellar segment dark brown; 1st flagellar segment elongated, 1.8 times as long as 2nd one. Maxillary palp (Fig. 9A) medium to dark brown, with 5 segments, proportional lengths of 3rd, 4th, and 5th segments 1.00 : 0.93 : 1.59; 3rd segment (Fig. 9B) somewhat enlarged; sensory vesicle

nearly globular, 0.22 times as long as 3rd segment, with small opening. **Thorax.** Scutum orange brown except narrow portions along lateral margins medium brown, with pair of medium brown submedian triangular spots just anterior to prescutellar area, slightly shiny at certain angle of light, moderately covered

with yellow scale-like recumbent short hairs intermixed with dark similar hairs, and with several dark brown upright usual simple hairs on prescutellar area. Scutellum medium brown, with dark upright usual simple hairs as well as yellow scale-like short hairs. Postnotum orange brown, with medium brown round spot medially, slightly shiny at certain angle of light, thinly white pruinose, bare. Pleural membrane dark brown, moderately covered with yellow fine hairs interspersed with a few dark brown hairs. Katepisternum longer than deep, orange brown except narrow portions along upper margin somewhat darkened, slightly shiny at certain angle of light, densely covered with yellow and dark brown short hairs. **Legs.** Color pattern, hair covering and shape of legs almost the same as those of male of *S. (W.) suyoense* sp. nov. Fore basitarsus slightly dilated, 8.0 times as long as its greatest width. Hind basitarsus (Fig. 9C) slender, parallel-sided, 6.33 times as long as wide, 0.63 and 0.54 times as wide as greatest widths of tibia and femur, respectively; calcipala (Fig. 9C) reaching basal 1/3 of 3rd tarsal segment, somewhat curved and twisted inwardly; pedisulcus (Fig. 9C) well developed at basal 1/3 of 2nd tarsal segment. **Wing.** Length 1.9 mm; other characters as in male of *S. (W.) suyoense* sp. nov. **Abdomen.** Nearly as in male of *S. (W.) suyoense* sp. nov. **Genitalia.** Coxite in ventral view (Fig. 9D) subquadrate, 2.1 times as long as wide; coxite in medial view somewhat flattened ventrodorsally. Style in ventral view (Fig. 9D) slender, somewhat narrowed medially, moderately curved inwardly, with blunt apex having 1 apical spine; style in ventrolateral view (Fig. 9E) 1.95 times as long as its widest at base, 0.67 times as long as coxite, gradually tapered toward apex, with round apex; style in posteroventral view (Fig. 9F) markedly tapered from base to basal 3/5, then narrowly parallel-sided toward apex. Ventral plate in ventral view (Fig. 9D) transverse, 0.75 times as long as greatest width near base, with anterior margin produced anteriorly and weakly defined, lateral margins greatly narrowed posteriorly, and posterior margin having 2 shallow concavities medially, and densely covered with microsetae on medial portion of ventral surface; basal arms short and slender, directed forwardly and somewhat inwardly; ventral plate in posterior view (Fig. 9G) with medial portion moderately produced

ventrally, and densely covered with microsetae on median portion of posterior surface; ventral plate in lateral view (Fig. 9H) with ventrally produced median process. Median sclerite (Fig. 9D, H) thin, of moderate width and rounded apically, similar to that of *S. (W.) suyoense* sp. nov. Paramere slender, well sclerotized, with 4 long stout hooks and a few shorter ones. Aedeagal membrane including dorsal plate as in *S. (W.) suyoense* sp. nov. Ventral surface of 10th segment (Fig. 9I, J) without distinct hair though 1 short hair present on lateral surface of left side. Cercus (Fig. 9I, J) small, not produced, encircled with 12 or 13 short hairs.

Pupa. Body length (excluding gill filaments) about 3.0 mm. **Head.** Integument yellow to light ochereous, bare; frons with 2 simple slender long trichomes on each side, lying along lateral margin somewhat separated from each other; face with 1 simple and 1 bifid slender long trichomes; antennal sheath without any projection, and bare. **Thorax.** Integument yellow to light ochereous, sparsely covered with conical tubercles except anterior 1/2 almost bare; integument on each side with 1 simple and 2 bifid long trichomes (Fig. 10A, B) medio-dorsally, 1 long and 1 medium-long simple trichomes (Fig. 10C, D) anterolaterally, 1 simple medium-long trichome (Fig. 10E) posterolaterally and 3 simple short trichomes (Fig. 10F) ventrolaterally. Gill (Fig. 10G, H) composed of 4 slender filaments each directly arising from base; 1 filament directed upward, then curved forward and downward, 2 filaments directed forward, and 1 filament slightly directed downward, then forward; uppermost filament shortest (1.2 mm long), 3 other filaments almost the same in length (1.6 mm long); all filaments light brown, tapered toward apex, subequal in thickness to one another, without annular ridges though having shallow annular furrows in irregular intervals on their surface, and densely covered with minute tubercles. **Abdomen.** Dorsally, segment 1 weakly sclerotized, light ochereous, very sparsely covered with minute tubercles, with 1 simple short slender seta on each side; segment 2 weakly sclerotized and light ochereous on basal 1/4 to 1/2, very sparsely covered with minute tubercles, with 5 very short simple spines (4 stout, 1 slender) and 1 short simple slender seta along posterior border on each side; segment 3 weakly sclerotized and light ochereous on basal 1/4, and bare; segments 3 and 4 each with 4 hooked

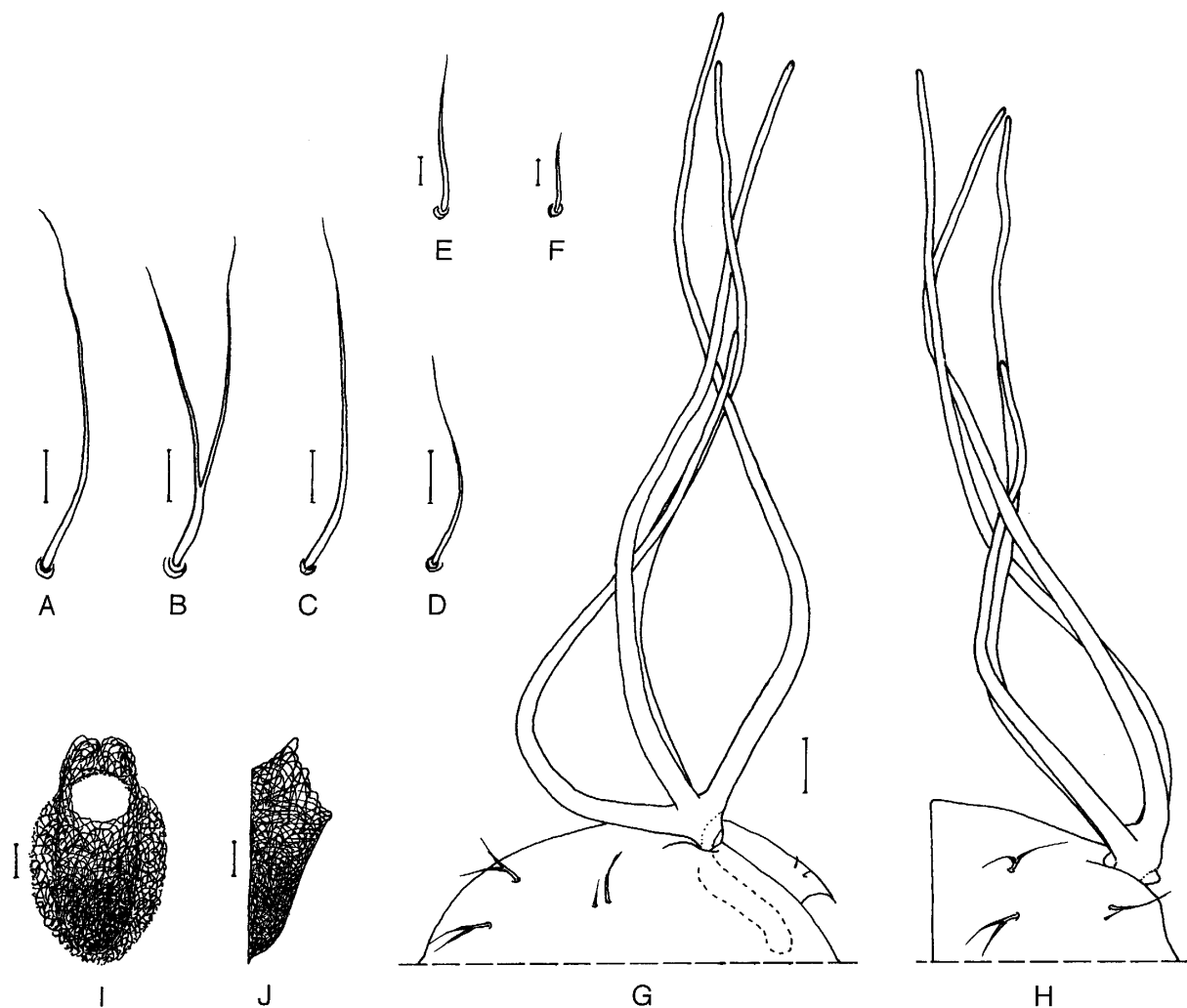


Fig. 10. Pupa of *Simulium* (*Wallacellum*) *molawinense* sp. nov. A-F, thoracic trichomes (A and B, mediiodorsal; C and D, anterolateral; E, posterolateral; F, ventrolateral); G and H, gill filaments with anterior part of thorax (right side; G, lateral view; H, dorsal view); I and J, cocoons (I, dorsal view; J, lateral view). Scale bars. 0.5 mm for I and J; 0.1 mm for G and H; 0.02 mm for A-D; 0.01 mm for E and F.

spines directed forward and 1 very short simple spinous seta on each side; segment 5 transparent, bare, with a few very short simple setae; segments 6-8 each transparent, with comb-like groups of minute spines directed caudad, and a few very short simple setae on each side; segment 9 weakly sclerotized, light ochreous, with pair of distinct conical terminal hooks directed caudad, similar to those of *S. (W.) claveriaense* sp. nov., as well as comb-like groups of minute spines directed caudad on each side. Ventrally, segment 3 transparent, with a few simple minute setae; segment 4 transparent, with 1 simple or bifid hook (subequal to, or slightly smaller than, those on segments 5-7), 1 simple hooklet and a few minute setae submedially on each side; seg-

ment 5 transparent, with pair of bifid hooks and a few minute setae on each side; segments 6 and 7 each with 1 bifid inner hook and devoid of outer hook, and with a few minute setae on each side; segment 8 almost transparent or very weakly sclerotized, and with a few minute setae; segments 3-8 each with comb-like groups of minute spines directed caudad on each side; segment 9 weakly sclerotized and light ochreous, bare, and without grapnel-like hooklets ventrolaterally. **Cocoon** (Fig. 10I, J). Shoe-shaped, roughly woven leaving tiny open spaces in webs anteriorly, and moderately extending ventrolaterally; individual threads visible; floor moderately woven on posterior 1/2; 3.5 mm long by 2.3 mm wide.

Female and Mature larva. Unknown.

TYPE SPECIMENS. Holotype male (with its associated pupal exuviae and cocoon), reared from a pupa, collected from a mountain stream of Molawin Creek (width 4–7 m, depth 2–5 cm, shaded, water temperature 22°C, altitude 192 m), Flat Rocks, foot of Mt. Makiling, Los Baños, Laguna Province, Luzon Island, Philippines, 24.I.2001, by H. Takaoka. Paratypes: 1 male (reared from a pupa) and 2 pupae, collected from a mountain stream (width 3–5 m, shaded, water temperature 23.8°C, altitude 169 m), Maria Makiling Falls, Barangay Lalakay, Los Baños, Laguna Province, 22.IX.2006, by H. Takaoka.

ECOLOGICAL NOTES. The pupae of this new species were found on a dead tree leaf and grasses trailing in the water of moderately or rapidly flowing forest streams. Associated species were *S. (G.) liliwense*, *S. (G.) luzonicum*, *S. (S.) balta-zarae* Delfinado, *S. (S.) melanopus* Edwards, *S. (W.) carinatum* Delfinado, *S. (W.) recurvum* and *S. (W.) tuyense*.

ETYMOLOGY. The species name *molawinense* refers to the Molawin Creek, where this new species was collected for the first time.

REMARKS. This new species seems to be most closely related to *S. (W.) recurvum* Takaoka described from Luzon and Negros Islands (Takaoka, 1983) judging from the shape of the male genitalia, in particular, posteriorly-narrowed ventral plate, and the four pupal gill filaments, of which the dorsalmost filament is shorter than the others, and having no annular ridges on their surface. However, *S. (W.) molawinense* sp. nov. is easily distinguished from *S. (W.) recurvum* by the following characteristics (those of *S. (W.) recurvum* in parentheses): the male large eye-facets in 15 horizontal rows (in 12 horizontal rows), the dorsalmost pupal gill filament directed upward and forward (Fig. 10G) (directed

upward, bent inward and further posteriorly), and the cocoon shoe-shaped (Fig. 10I, J) (wall-pocket-shaped).

This new species is remarkable in having the shoe-shaped cocoon (Fig. 10I, J) among the species of the subgenus *Wallacellum*, all the 11 known species being reported to have the wall-pocket-shaped cocoon except *S. (W.) ogonukii* Takaoka described from the female, pupa and mature larva collected from Mindanao Island (Takaoka, 1983), which has the shoe-shaped cocoon. However, *S. (W.) ogonukii* has several different characteristics including the pupal antennal sheath with saw-like spines, the four pupal gill filaments of subequal length and with annular ridges on their surface.

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REFERENCES

- Chung, C. L. 1986. A new record of *Simulium (Wallacellum) yonakuniense* from Lanyu Is., Taitung county, Taiwan (Diptera: Simuliidae). *J. Taiwan Mus.*, 39: 1–10.
- Takaoka, H. 1972. A new species of Simuliidae from Yonakuni Island, Ryukyu Islands, Japan (Diptera: Simuliidae). *J. Med. Entomol.*, 9: 521–523.
- Takaoka, H. 1983. The Blackflies (Diptera: Simuliidae) of the Philippines. xii + 199 pp., Japan Society for the Promotion of Science, Tokyo.
- Takaoka, H. 2003. The Black Flies (Diptera: Simuliidae) of Sulawesi, Maluku and Irian Jaya. xxii + 581 pp., Kyushu University Press, Fukuoka.